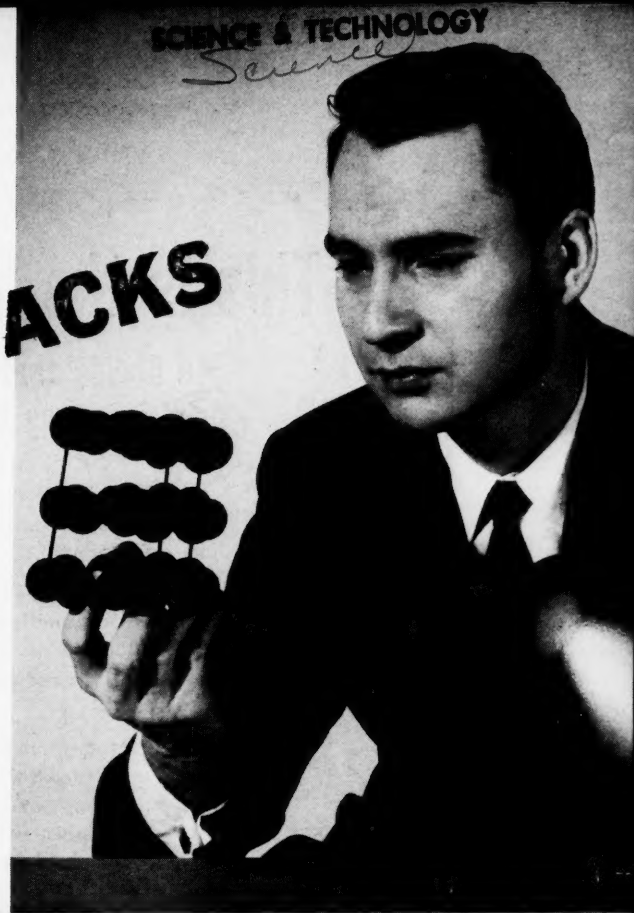

Story of Pyrolitic Graphite
Southwestern Metal Congress
(See article, p. 4)

June, 1960

MR

METALS REVIEW

The News Digest Magazine

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METALS REVIEW

The News Digest Magazine

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Important Lectures

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Pyrolitic Graphite Described at Southwestern Metal Congress

A NEW MATERIAL which can be considered for applications involving extremely high temperatures was described at the Southwestern Metal Congress, Dallas, Tex., during the week of May 9. The new material is pyrolitic graphite, which is just beginning to become available in commercially usable sizes.

The heat resistant material was described in two papers presented by engineers of the General Electric Research Laboratory, Schenectady, N.Y. R. J. Diefendorf presented a paper on the "Preparation and Properties of Pyrolitic Graphite" and E. R. Stover covered "Selection of High-Strength Carbons for High-Temperature Applications". The papers were among six devoted to a general discussion of composite materials for high-temperature application.

What is believed to be the largest piece of pyrolitic graphite ever produced has been made in the General Electric Research Laboratory. It is a rectangular piece 1/8 in. thick, measuring 17 by 31 in. As production techniques are developed to the point of making the material available in commercial quantities, it is expected to find application in such products as missile nose cone heat shields, rocket engine nozzles and the steering vanes of missiles.

In nonmilitary areas, the new form of graphite can also be considered for hot pressing dies and as a heat resistant material in melting crucibles for metals, ceramics and semiconductors. Another possible use is in nuclear reactors.

In itself, pyrolitic graphite is not new. It was first patented by Thomas Edison in 1883 and was used to coat electric light filaments. The element of newness comes in the ability to make the material in large sizes.

Heat resistance of pyrolitic graphite results from its atomic structure in which graphite crystals are arranged in orderly stacks and layers. Heat travels many hundreds of times more easily along the layers of pyrolitic graphite than through them. Other properties of the material also vary greatly, depending on the direction in which they are measured.

Above 3000° F. the material has the highest strength-to-weight ratio of any high-temperature material now being considered. Above 5000° F. it has a tensile strength of approximately 40,000 psi., as compared to less than 1000 psi. for tungsten.

Measured in the favorable direction, pyrolitic graphite has a flexural strength of about 25,000 psi. High density of the material makes it impervious to liquids and gases in sheets only one or two mils thick. Low chemical activity in this form of graphite greatly increases its oxidation resistance.

Pyrolitic graphite is produced by placing a heated piece of commercial graphite in a stream of hydrocarbon gas, such as methane. Carbon in the gas is deposited in the surface of the original sample while the hydrogen passes off. As the new material grows, crystals of graphite, composed of carbon atoms, form with their flat planes parallel to the existing surface. In a short period, an almost completely homogeneous structure has been built up, consisting of close-packed columns of graphite crystals. These crystals are joined to each other along the flat planes by strong bonds; there are only weak bonds between layers, thus the difference in properties, depending upon the direction of measurement.

Other papers in the session included "Metal-Metal-Oxide Alloys for High-Temperature Applications", by Nicholas Grant, Massachusetts Institute of Technology, and Klaus Zwilsky, New England Materials Laboratory; "Metal-Fiber Reinforced Ceramics and Metal-Ceramic Laminate Composites", by J. R. Tinklepaugh, Alfred University; "Composite Materials for Thermal Protection", by E. Scala, Avco Research and Advanced Development Division, and "Design of Graphite Leading Edges for Hypersonic Gliders", by Frank Anthony, Bell Aircraft Corp.

The Southwestern Metal Congress also featured other sessions covering "Steels for High Load Applications", "New Frontiers in Metal Processing", "Failure Analysis", "Testing at High Temperatures" and "Castings for High-Temperature and Corrosive Service".

The Cover

A pyrolitic graphite piece shaped like a nose cone heat shield and a model representing the atomic structure of the material are held by Russell J. Diefendorf, General Electric Research Laboratory, Schenectady, N.Y.

William A. Pennington

Carl E. Swartz

Announce 1960-61 National ASM Officer Nominations

Nominations for national officers for 1960-1961 have been announced by the A.S.M. Nominating Committee, which met in Columbus, Ohio, May 17, under the chairmanship of A. F. Sprankle (Southeast Ohio Chapter), Vanadium Corp. of America, Cambridge, Ohio.

Offices to be filled are president, vice-president, secretary and two members of the board of trustees. Terms of the secretary and trustees are two years, other terms are one year.

William A. Pennington, now serving as A.S.M. vice-president, is the nominee for president, Carl Swartz for vice-president, Merrill Scheil for secretary. Nominees for the board of trustees are Morris Cohen and John Convey.

According to the constitution of the American Society for Metals, additional nominations for any of these posts can be made by written petition to the secretary of the Society. Petitions must be signed by 50 members of the Society and received at A.S.M. headquarters prior to July 15, 1960. If no additional nominations are received prior to the stated deadline, nominations shall be closed and at the annual meeting in October 1960, the secretary will cast a unanimous vote of the members for these candidates.

William A. Pennington

William A. Pennington, nominated for president, is professor of metallurgy at the University of Maryland. Prof. Pennington received his B.S. in chemistry from Union University, Jackson, Tenn., in 1925, and his doctorate at Iowa State College, Ames, in 1933. Prior to associating with the University of Maryland in 1953, Dr. Pennington served as a research engineer with Armco Steel Co., Middletown, Ohio. For four years he was in charge of a fellowship on foundry practice at Mellon Institute, Pittsburgh. Immediately prior to joining the University of Maryland, Dr. Pennington was chief chemist and metallurgist for Carrier Corp., Syracuse, N.Y.

While at Carrier, he invented Refrigerant-500, the only commercial azeotropic refrigerant in use today. Dr. Pennington started his work on surface decarburization of steel at Armco and continued this activity at Mellon Institute. Recognition for this work came in 1947 when he was awarded the A.S.M. Henry Marion Howe Medal.

In addition to the American Society for Metals, his memberships include American Society of

Refrigeration Engineers, Phi Lambda Upsilon, Alpha Chi Sigma, Sigma Xi, American Chemical Society, American Institute of Chemists and New York Academy of Sciences. He is a fellow of the American Association for the Advancement of Science and an honorary member of Alpha Sigma Mu.

Dr. Pennington served as national treasurer A.S.M. in 1953-55. In 1948 he was chairman of the Syracuse Chapter. National chairmanships include the Publications, Howe Medal, Finance and various Metals Handbook committees.

Carl E. Swartz

Carl E. Swartz, nominated for vice-president, is a consulting metallurgist with headquarters in Hinsdale, Ill. He received his B.S. degree from University of Illinois and his M.S. and Ph. D. degrees from University of Wisconsin. He did special post-graduate work at Rutledge, University of California and Harvard Graduate School of Business Administration.

Before establishing his own consulting organization, Dr. Swartz served as research metallurgist, American Smelting and Refining Co., chief metallurgist, Cleveland Graphite Bronze Co., division metallurgist, Kellex Corp., and chairman of metals research, Armour Research Foundation.

Dr. Swartz was chairman of the Cleveland Chapter A.S.M. and on the executive committees of the Washington and Chicago Chapters. He is a founder-member and the first chairman of the Chicago-Western Chapter.

Dr. Swartz is presently chairman of the A.S.M. Long-Range Planning Committee. He served as national trustee, 1956-1958, and was a member of the Nominating Committee in 1943.

Merrill A. Scheil

The nominee for the two-year term as A.S.M. secretary, Merrill A. Scheil, is director of metallurgical research, A. O. Smith Corp., Milwaukee. He was awarded his B.S. in chemical engineering in 1927 and his M.S. in metallurgy in 1930 from University of Wisconsin.

Mr. Scheil's professional career started at Gisholt Machine Co., Madison, Wis., where he served as a metallurgical chemist. Two years later he became associated with A. O. Smith Corp., where he has continued until the present. Starting as a metallurgist, he later became a metallurgical engineer and in 1940 was appointed director of metallurgical research.

Mr. Scheil has been active in both local and national activities of A.S.M. for many years and is presently serving the second year of his two-year term as national trustee. He is a past chairman of the Milwaukee Chapter, has served on several Metals Handbook committees and, in addition, has been a member of the Metal Progress Advisory Committee. He was on the National Nominating Committee in 1948.

A registered engineer in the state of Wisconsin, Mr. Scheil is active in many technical and professional organizations, including the British Iron and Steel Institute. His technical and professional writings have been published widely.

John Convey

John Convey, nominee for trustee, was born in England. He completed secondary school there, then came to Canada in 1929, settling near Edmonton. He obtained his B.S. and M.S. degrees in physics from the University of Alberta, and, after a short time as lecturer in physics there, he proceeded to the University of Toronto, where

M. A. Scheil

Morris Cohen

John Convey

he earned his Ph.D. degree in atomic physics.

He joined the Canadian Navy in 1940 and was sent on loan to the Royal Navy in England. After Dunkirk and the Battle of Britain, he was assigned to the Scientific Research Department and spent six years at the Sheffield Laboratories working on a variety of problems dealing with operational research. During this time he was in charge of metal physics.

Dr. Convey returned to Canada in June 1946, joining the staff of the University of Toronto as associate professor of physics. In 1948 he joined the Mines Branch staff as chief of the Physical Metallurgy Division, and became director of the Mines Branch in 1951.

Dr. Convey is active in many British, Canadian and American technical societies. He received the Sorby Prize, Sheffield, in 1944 for original work in metallurgical research, the Canadian Institute of Mining and Metallurgy Blaylock Medal for contributions in the development of atomic energy in Canada in 1956, and was granted an honorary Ph.D. degree by McMaster University in 1959 for distinguished work in the field of metallurgical research.

Morris Cohen

Morris Cohen, nominee for trustee, received his B.S. degree in 1933 and his Ph.D. degree in 1936 from Massachusetts Institute of Technology. He became an instructor of metallurgy at M.I.T. in 1936, assistant professor in 1937, associate professor in 1941 and professor of physical metallurgy in 1946.

During World War II, Dr. Cohen was associate director of the Manhattan Project at M.I.T., and served as an official investigator for the Office of Scientific Research and Development. He was a consultant for the Boston Ordnance District and a member of the War Products Advisory Committee. He is now a consultant to the U.S. Atomic Energy Commission.

No stranger to A.S.M. honors and activities, Dr. Cohen was in 1945 and again in 1949 a joint recipient of the Society's Howe Medal. He received the Sauveur Memorial Award of the Boston Chapter in 1947, and was the Sauveur Lecturer for the Philadelphia Chapter in 1959, the Woodside Lecturer for the Detroit Chapter in 1959 and the Coleman Lecturer for the Philadelphia Chapter in 1960. He presented the Campbell Memorial Lecture for A.S.M. in 1948, and gave the Burgess Memorial Lecture and the Carnegie Memorial Lecture for the Washington and Pittsburgh Chapters as well.

Dr. Cohen was given the A.I.M.E. Institute of Metals Award in 1950, the Kamani Medal of the Indian Institute of Metals in 1952, the Mathewson Gold Medal of A.I.M.E. in 1953, and Franklin Institute's Clamer Medal in 1959.

Dr. Cohen, a member of several technical societies and a fellow of the American Academy of Arts and Sciences, served as chairman of the Institute of Metals Division A.I.M.E. in 1953, and chairman of the Boston Chapter A.S.M. in 1954. He has been active in the fields of phase transformations, metallography, heat treatment, solid-state diffusion, thermodynamics, mechanical behavior of metals, toolsteels and age hardening.

To Direct Metal Congresses

APPOINTMENT OF T. C. DU MOND as manager, National and Regional Metal Congresses, American Society for Metals, has been announced by Allan Ray Putnam, managing director.

DuMond has also been appointed director, Membership and Chapter Relations, confirming a responsibility he has held for a number of months. He will provide liaison, counsel and direction for the Society's 31,500 members in 112 chapters in the U. S. and Canada.

In his Metal Congress function, he will work with national A.S.M. committees in selecting subjects and titles for papers, panels and symposia, and in obtaining authors, speakers and session chairmen. He will also work with members of other societies to coordinate their technical programs with the A.S.M. Metal Congresses.

As editor of "Transactions", the annual record of scientific papers presented at the Metal Congresses, DuMond works with the national Transactions Committee in publishing outstanding papers. He is also editor of *Metals Review*.

DuMond

Before joining the Society's headquarters staff in 1957, DuMond served for ten years as editor of *Materials and Methods*, now *Materials in Design Engineering*. He is author of three technical books, "Fabricated Materials and Parts", "Shell Molding and Shell Mold Castings" and "Engineering Materials Manual".

Use of the Plasma Torch for Metal Cutting

DAVID SWAN, formerly vice-president-research, Linde Co., spoke in New York on "The Plasma Torch: a New Way to Cut Metals".

Mr. Swan began by tracing the history of plasma torches, which were conceived about 30 to 40 years ago in Germany but found no practical application. The next step was the development during World War II of inert-gas welding processes, which showed it was possible to operate an arc in inert atmospheres with nonconsumable electrodes. The final step came about five or six years ago when Gage discovered practical means of constricting the arc with a nonconsumable metal nozzle.

The first application of the plasma torch was for cutting and severing operations. Today it is widely used commercially for cutting heavier aluminum pieces and stainless steels.

Later the advantages of the plasma torch for depositing materials were realized. As compared to the classic metal spray gun, the plasma torch has higher temperatures, better heat transfer and can operate with inert gases so there is virtually no limit as to what can be deposited with it. Among its possibilities are the deposition of boron on nickel to suppress electron emission; barium compounds on molybdenum cathodes for low-temperature electron emitters; platinum and palladium for thermocouple elements; crucibles of refractory materials; permanent molds of graphite coated with aluminum, zirconium or silicon nitride; and manganese oxide on Inconel screens for catalyzing the decomposition of hydrogen peroxide.

In addition to coating processes, it is relatively easy to produce refractory parts with the plasma torch by depositing the metal, tungsten, for instance, on a mandrel, which is subsequently removed chemically. The part can then be further treated if desired. Tungsten has a density of 94-95% as deposited, with a modulus of rupture of about 45,000 psi. and a Young's modulus of 22,000,000 psi. After removal of the mandrel and sintering for 2 hr. at 1400° C., these values are raised to 97-99%, 57,000 psi. and 35,000,000 psi. It might be possible to approach the properties of conventionally produced tungsten more closely, but this is not necessary for products such as rocket nozzles.

Because of their intensely high heat, plasma torches have a wide range of possible future applications, such as chemical reactor, a high-intensity light source, a means of melting metals and for testing missile materials. Now that it is feasible to vary considerably the characteristics of electric arcs at will, it is virtually certain that many more applications will be developed. *(Reported by Bruce Fader for New York)*

Fred Stirbl, Hospitality Chairman, Leslie Seigle, Chairman, David Swan, Linde Co., Who Spoke on "The Plasma Torch: a New Way to Cut and Coat Metals", and Ludwig Anselmini, Vice-Chairman, Relax at a New York Meeting

Problems of Metal Joining Reviewed

MEMBERS ATTENDING THE 258TH meeting of the New Jersey Chapter enjoyed a lecture entitled "Metallurgical Problems in Metal Joining", by Isaac S. Goodman, welding engineer, Lamp Division, Westinghouse Electric Corp.

Mr. Goodman opened his lecture with a review of some of the older joining processes, including soldering, brazing, forge welding, flow welding

Henry Skarbe, Ted Gela and Isaac S. Goodman, Westinghouse Electric Corp., Discuss "Problems of Metal Joining" at New Jersey

and thermit welding. Although several of these joining methods, especially soldering and brazing are still extensively used, resistance and arc welding are beginning to dominate the field of metal joining today.

Development of the tungsten, inert gas-shielded arc process, one of the major advances in the welding art, was sparked by the war-time demand for better methods of joining aluminum and magnesium alloys. The consumable electrode inert gas-shielded arc process was announced a few years later.

Recent research has been directed towards application of energy in forms other than flame, furnace or arc heating. For instance, ultrasonic welding is accomplished with acoustical energy. Extremely thin materials can be joined to thick materials, dissimilar metals can be welded and metals can be bonded to nonmetals with this process.

The electron beam process makes use of the same principle as the X-ray machine wherein a focused beam of electrons strikes a metal target which is the workpiece in this instance according to Mr. Goodman.

Mr. Goodman then discussed the problem of bonding two pieces without altering the properties of the metals being joined. The minute size of such parts as lamp filaments and supports magnifies the difficulty manyfold. Furthermore, the high-temperature thermal cycles encountered in service can rapidly destroy an apparently good joint by reason of phase changes and alloying of the base metal with filler materials.

Mr. Goodman closed with a plea for cooperation among designers, metallurgists and welding engineers to prevent nullification of the efforts of one because of ignorance on the part of another. *(Reported by James G. Bielenberg for the New Jersey).*

High-Temperature Protective Coatings

"METALLURGICAL ASPECTS OF PROTECTIVE Coatings for High Temperatures" were reviewed by Charles L. Faust, chief, Electromechanical Engineering Division, Battelle Memorial Institute, before the Akron Chapter.

Dr. Faust focused his talk on the very surface of the metal bulk (zero to a few hundredths of an inch), and introduced a new term, "surface metallurgy", to his audience. It is important to note that the surface differs in properties from the base metal because of finish disturbances and perhaps even nonmetallic inclusions such as polishing grit.

The need for obtaining a perfect surface before applying a coating for optimum performance cannot be overstressed. Surface condition affects the crystal structure of the plating. The fact that the surface structure is different than the base metal structure, with different properties, has not been recognized as it should be.

The bond strength of a metal to a metal can be equal to the strength of the weaker of the two metals. Surface smoothness is not the only criterion of coating performance. Other factors are hardness and depth of surface disturbance and disarrangement.

The effects of holes in the surface to be coated was also considered. It is interesting to note that almost regardless of deposition method, the larger holes can't be filled; rather, they will be lined by the coating.

Multilayer coatings will be very important in this space high-temperature age. Fluctuating temperature service, erosion of high-velocity gases and corrosion are only some of the reasons which have turned the metallurgist to multilayer coatings. (Reported by C. F. Moewe for Akron).

Submerged Arc Welding Techniques and Developments

MEMBERS OF THE YORK CHAPTER heard William B. Sharav, head, Laboratory Division, Linde Co., speak on "New Developments and Techniques in Submerged Arc Welding".

Mr. Sharav first presented the fundamentals and new developments in the field of submerged arc welding and surfacing. He pointed out that it is not basically a new development since it dates back to 1935, but that, until the last decade, few advancements in the process were made.

The submerged arc welding process is inherently the most versatile with regard to power supply. It may use any conventional source, d-c. constant current or constant potential, straight or reverse, a-c., generated or transformed.

New developments by the Linde Co. include multi-power welding, which employs two energized electrode feed wires; constant potential welding, in which the arc voltage is controlled by the power supply and the welding current by the wire feed; stitch welding, which is an intermittent bead, wherein the spacing is controlled by the burn-off rate of the wire and the feed speed, which enables the attainment of very high speeds—up to 200 in. per min.

A method for hard facing and stainless cladding of vertical surfaces, called the "Three O'Clock" technique, and the cold wire technique, which enables better control of the melting in the fusion zone by means of the insertion of a nonenergized filler wire, were discussed.

Methods of altering the weld chemistry during welding include direct insertion via a vibratory feed of granular metal into the melt and alloyed composition of the flux. Both methods allow the use of a plain carbon steel base metal and a mild steel electrode.

The very new developments in the welding of T-1 steel were then covered. Joining techniques and welding materials are available to develop weld metal with mechanical properties essentially identical with the base metal in either the as-welded or stress-relieved condition.

Mr. Sharav ended his talk with a discussion of the newly developed Russian method of electroslag welding, the origin of which can be traced back to the old American method of mold welding. *(Reported by R. D. Sams for York).*

Vacuum Degassing of Steel

MICHAEL V. HERASIMCHUK, METALLURGICAL supervisor, Bethlehem Steel Co., lectured on "Vacuum Degassing of Steel" at Buffalo.

Patents on vacuum degassing were issued as early as 1877; at that time, a letter of patent in England suggested a vacuum to be created by an exhaust jet of steam.

The construction of vacuum degassing units has increased rapidly since 1950; Japan has five units operating, Germany has at least five units, Italy has two, France has three and Russia at least seven units of various capacities.

The foremost objective of degassing metals is the removal of hydrogen which causes flaking; oxygen content will also be reduced. Steam degassing of metals in the U.S. at the present time is largely confined to ingots for heavy forgings for the utility industries. Since the introduction of the ultrasonic machine, in the late 1940's, it has been possible to determine the internal structure of metals. Nonmetallic inclusions, as well as voids, gave pips on the ultrasonic tester, so interpretation became a big problem between the forging producers and users. In the early 1950's the problem of sonic indications was tackled as a joint effort and vacuum degassing was introduced to reduce the hydrogen content of steel to the lowest possible level.

Bethlehem Steel conducted a research project on hydrogen in steel during which over 900 heats were analyzed for H_2 content at various stages of melting and pouring. In the summer the H_2 content in the metal was higher; the cause was traced to the higher humidity in the Lehigh Valley during the summer months.

Receives Silver Certificate

Walter Hodapp Is Shown Being Congratulated by Syracuse Chapter Chairman Henry Holbert, on the Occasion of His Receiving His Silver Membership Certificate

Bethlehem has a four-stage, 250-ton steam ejector unit with a 36-in. line to the degassing chamber. Vacuum instrumentation consists of an ionization gage and thermocouple gages. It takes less than 45 min. to pump the vacuum down to less than 1 mm. Pressure stays relatively constant during pour (around 700 microns). The ingots have the normal shrinkage cavity, piping is still the same and solidification characteristics are not changed. Pouring is stopped at the sink head level and the sink head refractories must be of high quality. Surface conditions on the ingots are problems and they vary with the type of steel. The gases evolved analyzed 30% Co, 30% N_2 and 30% H_2. The degassing of steel greatly increases the elongation and reduction of area in comparison to conventional materials. (Reported by M. M. Hughes for Buffalo).

How Commercial Heat Treaters Can Aid Industry

THE NEW JERSEY CHAPTER recently held a panel discussion on "Commercial Heat Treating Industry Benefits". Panel members R. Bloss, plant manager, Benedict Miller, Inc., H. Dobkin, vice-president, L. R. Metal Treating Corp., D. Mazer, president, Bennett Heat Treating Corp., and R. Misshula, vice-president, Alfred Heller Heat Treating Co., brought an aggregate of 75 years of heat treating experience to this discourse.

Mr. Mazer opened the session with a discussion of the economics of heat treating, contrasting the cost of subcontracting with that of an in-plant operation. Many factors must be considered if a true comparison is to be made and some are frequently overlooked. Labor rates for skilled operating and maintenance personnel, overhead, value of floor space, insurance rates, duty cycle on equipment, cost of fuel and electric power and investment in equipment must be taken into account to obtain a true picture of manufacturing heat treating costs.

Mr. Dobkin continued the presentation by emphasizing the quality and service aspects related to subcontract heat treating. The modern commercial heat treater must possess diverse equipment, skilled personnel, adequate testing facilities and a reservoir of knowledge gained through experience if he wishes to stay in business. Most shops give fast service because they operate 24 hr. per day and even provide trucking for steady customers. Small lots can be expedited as long as standard cycles are required for their treatment.

Proper ordering procedures was the topic covered by Mr. Bloss. Orders must be written out, and requirements for case depth, hardness, surface finish, straightness, finishing allowance and adherence to formal specifications must be defined if a first-class job is expected. Specific billing and shipping instruction and the name of the authorized contact in the customer's organization should be supplied. If you give the custom heat treater these facts and tell him the type and brand name of the alloy, the rest is routine.

The fourth phase of the session was taken over by Mr. Misshula, who discussed causes of cracking in the heat treatment of steel. Some of the primary causes of tool damage are traceable to faults in the steel itself; others may be traceable to the heat treating operations, such as improper quench, insufficient tempering or improperly timed tempering. Finally, many flaws which are blamed on the heat treater actually stem from poor design of the part or may be caused in the tool shop by incorrect grinding. Mr. Misshula presented a number of slides depicting flaws which appeared either during heat treating or shortly thereafter. *(Reported by J. G. Bielenberg for New Jersey).*

A Heat Treating Panel at New Jersey Included, From Left: M. Margolis, Technical Chairman, H. Dobkin, R. Bloss, D. Mazer and R. Misshula

Grinding Steel Facts

W. E. LITTMAN, TIMKEN ROLLER BEARING CO., spoke on "Grinding of Steel or Thermal and Mechanical Aspects of Grinding Steel" at Detroit's Sustaining Members Night meeting.

Dr. Littman touched on five major points: mechanics of grinding; temperatures in grinding; structural changes resulting from grinding; residual stresses in grinding; and effect of grinding on performance. (Reported by T. C. King).

Authorities Tackle Problems in the Field of Castings

A PANEL OF AUTHORITIES discussed new developments in the "Field of Castings" at Hartford Chapter.

Mr. F. G. Sefing, foundry practice specialist, International Nickel Co., Inc., discussed gray, malleable and ductile iron. He emphasized the many variations in properties available in gray cast iron and uses of the various grades. The advantages of using malleable iron in thin-wall castings were covered. Variations in properties, such as mechanical properties and corrosion resistance, make ductile iron attractive as an engineering material.

W. O. Sweeny, executive vice-president of Arwood Corp., discussed investment casting capabilities. He emphasized that although close tolerances, such as 0.005 per in. per in. of dimension, can be achieved in investment castings, designers frequently think that precision greater than this is feasible. Investment castings should not, in this sense, be regarded as precision castings.

Most metals and alloys can be produced as investment castings. Currently the maximum producible casting weight is 100 lb. and the maximum dimension is 39 in. Investment casting should be regarded as a method for shaping an alloy into a part where other methods are not feasible.

E. L. Blackmun, Aluminum Co. of America, discussed developments in light metal castings. He covered the properties of aluminum castings suitable for elevated temperature applications, presenting data on alloy No. 142 and A140. He also discussed recent high ductility, high corrosion resistant casting alloys such as No. 220 and X250. The influence of composition on castability and mechanical properties in sand and die casting alloys was also covered. (Reported by F. M. Lister for Hartford).

Indianapolis Talk Features Phase Diagram Study

THE RELATION BETWEEN thermodynamics and phase diagrams, and the relation between X-ray diffraction and phase diagrams were presented by Bernard D. Cullity, department of metallurgical engineering, University of Notre Dame, at Indianapolis.

Thermal analyses, X-ray diffraction and microscopic methods are used in studying or determining phase diagrams.

Slides of graphs and charts showed the development of phase diagrams of alloys systems, using the fundamental formulas:

$$F = E - TS \text{ and}$$
$$S = k \ln W$$

In X-ray diffraction, the lattice parameter of the solid phase is studied. Alloy systems in equilibrium have a pattern; add an element or increase the amount of an element and the pattern will change. With X-ray diffraction the parameter of a solid solution is measured and plotted. In such ways phase diagrams are made. (Reported by Holbrook for Indianapolis).

Short-Cycle Heat Treatment

"THE EFFECTS OF SHORT-CYCLE HEAT Treatment on Cast Steels" were discussed by Dale Hall, Oklahoma Steel Castings, at Tulsa.

Mr. Hall emphasized that before working on heat treating cycles, the heating characteristics of the furnace should be studied thoroughly. Normalizing is not necessary to obtain good impact properties when it is to be followed by a liquid quench. Quenching from temperatures approximately 50° above the normal recommended quenching temperatures can reduce the time cycle appreciably. Graphs showing the effects of various times on the impact properties substantiated this concept. (Reported by R. L. Kerwin for Tulsa).

On Philadelphia Panel

A Panel Meeting Held in Philadelphia on "High-Temperature Alloys" Featured Robert F. Koenig, General Electric Co., A. M. Bounds, Superior Tube Co., and Norman L. Mochel, Westinghouse Electric Corp.

Half Century of Research in Glass

Shown at Syracuse where a Lecture-Demonstration by the Corning Glass Works, "Half a Century of Research in Glass", Was Presented, Are, From Left: H. Smith, Chairman of the Syracuse Section, A.I.Ch.E.; G. W. McLellan, the Speaker; and T. Crosby, Chairman

A CORNING GLASS WORKS lecture-demonstration, "Half a Century of Research in Glass", presented by C. W. McLellan, Technical Information Center, before the Syracuse Chapter, illustrated the versatile engineering capacities of glass and glass-ceramics.

Glass has been in use for more than 6000 years but has been little understood during most of this time. During the past 50 years, intensive research into the nature of glass has resulted in uncovering new and different compositions with widely varying properties. These new glasses permit applications in fields previously believed impossible.

Demonstrations, slides and motion pictures described the characteristics of products, ranging from radiation-shielding windows for atomic laboratories to precision electronic capacitors and resistors, from missile radomes to household skillets.

Glass was shown capable of withstanding prolonged operation at temperatures as high as 1900° F., as well as an abrupt plunge into ice water while red hot. Other compositions have the ability to selectively transmit or absorb chosen bands of radiant energy, infra-red, visible, ultra-violet, radio, X-ray and nuclear.

Items made from glass can be as light as cork or as strong as cast iron. Glass, normally an impermeable material, can be fabricated into a porous filter medium resistant to chemical attack and elevated temperatures.

Pyroceram, Corning's new family of ceramics made from glass, was treated in some detail. These materials are mechanically harder and stronger than glass, resist extreme thermal shock and maintain low-loss dielectric properties over a wide temperature range. Like glass they can be formed into a wide variety of shapes. This basic new discovery promises to provide answers for materials problems in many fields.

Metal Progress Appoints Assistant Editor

APPOINTMENT OF FRED L. SIEGRIST as assistant editor of *Metal Progress* has been announced by Allan Ray Putnam, managing director of the American Society for Metals.

Siegrist joins the expanding editorial staff of *Metal Progress* after three years as training supervisor for A.S.M.'s home-study division, the Metals Engineering Institute. Prior to that he served as staff metallurgist at Aluminum Co. of America, Lafayette, Ind., in development and quality control.

He is a veteran of over 12 years experience in diversified metallurgical operations, including testing and evaluating high-temperature alloys for jet engine applications at Wright Aeronautical Corp., Woodridge, N. J. He was also associated with Westinghouse Electric Corp., Pittsburgh, in research and development of nuclear reactor components.

A graduate of the University of Illinois in metallurgical engineering, he is a member of Alpha Sigma Mu, Tau Beta Pi and Phi Eta Sigma honorary societies. Other memberships include the American Welding Society and the Metallurgical Society A.I.M.E.

He has served on the executive and educational committees of Purdue Chapter, A.S.M., and is presently on the educational committee of the Society's Cleveland Chapter.

Fred and his wife, Dorothy, have two children.

METALLURGICAL NEWS AND DEVELOPMENTS

RUSSIAN METALWORKING REPORTS

A new *Digest of Soviet Technology* is designed to provide current information on Russian progress in metalworking. Issued monthly, the *Digest of Soviet Technology* contains about 40 condensations, in English, of Russian technical books and papers. The publication is available from Engineering Information Services, Ltd., Kirkham, Preston, Lancashire, England. Photocopies of original papers and translations are also available.

METAL-CERAMIC BRAZING PROCESS

A new process for brazing metal to ceramics is said to provide seals capable of withstanding temperatures up to 1100° F. Among the metals being brazed by the new method are several high-nickel alloys.

CERAMIC FIBERS IN METALS

Several organizations are working to perfect a composite material which combines ceramic fibers with metals to provide a structure considerably stronger than the base metal itself. Materials so created are designed to resist high heat, erosion and radiation. In some combinations considerable weight reduction can be achieved. In one cast example, compounded from 50% fiber and 50% metal, weight of an identical mass was considerably lower than in an all-metal structure.

POWDERED ALUMINUM IMPACTS

Aluminum parts for higher temperature service are expected to result from a new aluminum powder metallurgy impact extrusion process, by which powder metallurgy techniques are used to provide compacts which are impact extruded into final shape. One of the first parts made in this manner is a ¼-in. diameter finned tube in lengths up to 14 ft. with wall thickness tolerances in the 0.003-in. range.

ELIMINATE WELD CRACKS IN 4340 STEEL

Research conducted at Battelle Memorial Institute for Wright Field has determined that hot cracking in the weld deposits of SAE 4340 weld metals is caused by a combination of high sulphur and phosphorus contents. Investigations revealed that even though the total content of these elements is within specification limits, trouble can be expected if either exceeds about 0.017 wt. %. A limit of about 0.010% of each element is most desirable.

SEEKS TO PREDICT MACHINABILITY

A research project under way at University of Michigan to determine a method of predicting the machinability of a material through a study of its properties—mechanical, thermal and metallurgical, will, if successful, result in scales or equations for accurate prediction of the machinability of newer materials and eliminate the need for extensive machining tests.

ELECTRON BEAM VAPORIZER

Now available for commercial application is an electron beam vaporizer which can vaporize all metals including tungsten, tantalum, columbium and molybdenum. Prime use of the equipment is to reduce the metals to vapors for deposition as coatings on other materials. The equipment can be used with many existing vacuum systems.

DIES MADE BY GAS DEPOSITION

Pure nickel forming dies and foundry patterns are now being made without machining or hand work by a gas deposition technique known as the carbonyl process. Pure nickel is deposited on a soft metal mold or "negative" of the desired die or pattern; removal of the eutectic mold leaves a shell of pure nickel which is an exact duplicate of the original master. The shell is then filled with epoxy resin and metal fibers and backed with a steel plate. Dies, molds and patterns made by the process are being used in the automotive industry. The process is not suited for dies for shearing, blanking, cutting or extruding metals.

EXTRUDED STAINLESS STEEL

Economy in producing extruded stainless steel shapes has been achieved by forming directly from small cast billets, completely eliminating the usual rolling operations. Ingots from 5½ to 7½ in. are used as extruding billets. Strength of parts produced in this way is said to equal or exceed that of parts formed by conventional methods.

Many Metallurgists Still Needed

Take this insert out and pass it on to some bright boy who is still in high school or who has just graduated. Also try to sell him on your profession. (Article reprinted from *Metal Progress*, September 1958)

Production for Defense—the Air Force's Deadliest Interceptor—the F-106, in Production for the Air Defense Command at Convair's San Diego Plant. The delta-wing planes carry guided missiles and nuclear rockets for their mission of stopping enemy bomber attack in any weather, any time, day or night

Many Metallurgists Still Needed!

VISUALIZE THE WORLD without metal and what strange primitive conditions you would see! No automobiles, no airplanes, no television, no refrigerators. Even frying pans and table knives would be unknown. We would be back in the Stone Age!

Nature blessed us with about 65 metals, each different in some way from the others. Our grandfathers knew of about 16, and in ordinary life had seen fewer than that. Today, almost the whole 65 are in use somewhere, and man is not content with the 65; he must make new ones, some of which never before existed on earth unless for perhaps a fleeting instant when the earth first became compacted in the shape we now know it. We are speaking here of the metallic *elements*, not alloys which are mixtures of two or more elements. The alloys in every-day use number in the tens of thousands, and make a real problem for the engineers who must decide which is the best to use.

The men who have made this vast array of new

materials available are known as "metallurgists". While Mother Nature gave us the 65 metals to use she did it grudgingly, so mixing them up and compounding them in ores that the metallurgists' greatest ingenuity is taxed to find methods of separating and extracting them into a useful form. The people who do this work are in the field known as "extractive metallurgy". Their concern is the production of pure metal from the ore as it comes from the ground (and at least in one instance out of sea water!) However, getting the metals in the pure state does not in itself make them useful. Much more work needs to be done.

The "physical metallurgist" then takes over from the "extractive metallurgist". He is the one who has to know why one metal is different from another. Knowing this, he knows how to combine different metals in alloys in order to make them more useful. By studying their behavior he knows how he can improve their properties through working them in rolls or under forging hammers, or by giving them special heat treatments. Almost every service requires a different set of properties.

For an example, in atomic energy work the fissionable materials must be diluted by alloying to make usable fuel elements; the heat-exchanger piping through which the heat is carried away from the reactor to the electric generating equipment must withstand not only the temperature and pressure of the liquid but must also resist the damage from the enormous amount of radiation coming from the fuel element.

In missiles, what covering and what nose cone material must be used to take the intense heat generated by friction with the earth's atmosphere, and also the extreme temperature of the ionosphere? Meteorites are intensively studied, for they have had that experience and have solved the re-entry problem.

In recent automobiles, what material should be used in a torsion bar that bump after bump for millions of bumps must not stiffen and become brittle, nor relax and become weak, causing breakdown and even injury?

Commercially pure iron might be an ideal material for forming automobile bodies, but would be useless in engine parts. For these the iron must be alloyed to make steel of the high strength needed for springs, gears, connecting rods and crankshafts.

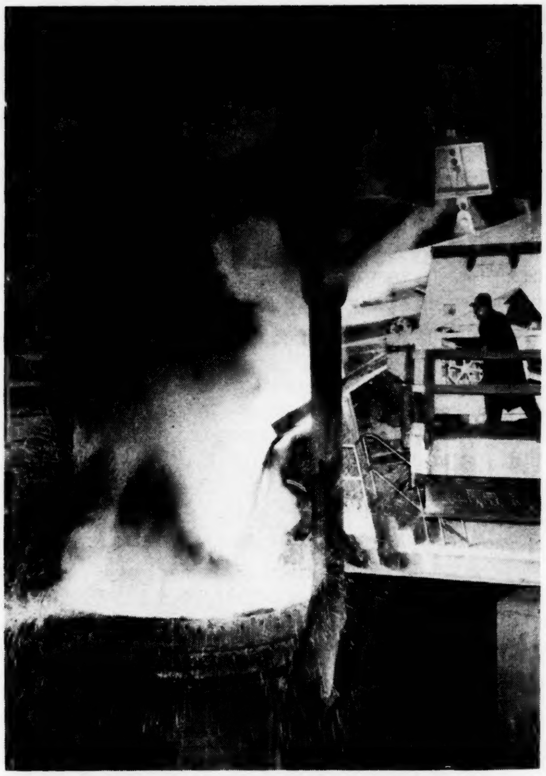
Everywhere one turns the demands are becoming more and more severe. That's why metallurgists are needed badly!

What Is a Metallurgist?

As the name implies, a metallurgist is one who makes the metals useful to mankind. In this sense there have been metallurgists since prehistoric times. With increase in knowledge of physics and chemistry, the modern metallurgist has applied this knowledge to the metals. Today, study of the atoms is one of his chief research functions, for atoms are the fundamental building blocks of the metals. They are assembled in the solid state in precise geometrical arrangements termed crystals. The individual crystals may be very large but ordinary pieces of metal are usually made up of very tiny crystals called grains. In general the smaller the grains the tougher the metal.

Other materials also may be crystalline, such as diamonds and other gemstones. However, the metals have properties not found in the nonmetallic materials, such as the ability to flow under applied load, the ability to conduct electricity, and "metallic luster", the property by which most of us recognize a metal. All of these, and other properties, are governed by the way the atoms are assembled in the crystals and the

High-Pressure Lines on the X-15 Are Brazed Instead of Thread Fastened to Provide a Tighter Joint. Here North American engineers show the line position on the mock-up of the X-15. The experimental research craft is primarily stainless steel to combat high-temperature conditions



Ferromanganese Fed by a Mobile Ladle Additions Feeder Goes Into the Ladle During Tapping of a 200-Ton Electric Furnace Built by Blaw-Knox Co. The feeder makes specific quantity additions of ferro-alloys to ladles, at controlled rates of feed. It is powered by a gasoline platform truck

forces holding the atoms together. The work of the metallurgist involves getting the different kinds of atoms in the right places to give the best properties. This may be done in the research laboratory on a scale that is microscopic or in the plant with ingots weighing as much as a hundred tons.

Manufacturing, Research and Development

Not all the same properties may be required at the same time. For machining in the factories the metal should be fairly soft but should be hardened and strengthened before it goes into service. By proper heating and cooling—"heat treatment"—the metallurgist sees that these requirements are fulfilled for each stage of the manufacturing operation. He must be sure that the proper material is selected which will respond correctly to this heat treatment.

Modern industry has an insatiable appetite for new and better materials of construction. Every large and many of the small producers in industry have laboratories for the development of new materials. Industrial users are fully as much concerned as producers. For example, the annual cost to the chemical industry due to corrosion failure is enormous.

Industries are intensely interested in the fundamental structure of the materials, for here lie the secrets of greater improvement. Tools and instruments for these investigations, although the most modern that have been devised, can scarcely keep pace with the needs of the research metallurgist in his probing ever deeper into atomic structure. Light microscopes, electron microscopes, radioactive isotopes and Geiger counters, X-ray apparatus, cathode-ray oscilloscopes—all these are familiar in every modern laboratory.

The new materials designed through this basic knowledge must be put in the hands of the ultimate user. This is a long road, from the laboratory through trial, production, sales and usage and comes under the general heading of development. Full-scale samples must be placed in the customers' hands for the most exhaustive tests to show that a superior material is being offered. The development metallurgist must follow every stage to eliminate the "bugs" as they appear.

Preparation and Qualifications

Before deciding to enter the field the prospective metallurgist of high-school age should survey himself to see if he has the necessary aptitudes and qualifications. A long course of training is required which does not stop with the acquisition of a college degree.

It begins even before entering college. The basic courses of science and engineering are required in metallurgy—these include algebra, geometry, trigonometry, physics and chemistry. These should be started in high school. The future metallurgist should have curiosity and imagination, especially about material things.

It will take him four years of college to earn a Bachelor of Science degree in metallurgical engineering. Necessary courses here include higher mathematics, physics, chemistry, mechanics and all available courses in metallurgy. For broader background will also be required English, history and economics.

Specific knowledge of particular alloy systems or metallurgical operations is usually required on the job after graduation. However, further study in graduate school is strongly recommended for those qualified. Here one may specialize in some branch of metallurgy and take part in metallurgical research.

Opportunities

Metallurgy is creative. To the individual who has aptitude and curiosity the field in unlimited. Such an individual would never be satisfied in a trade or as a technician.

Our nation has been built on its metalworking industry. Yet only some 600 metallurgists per year are being graduated from our colleges and universities to control 35 *billion* dollars of product! Even in the depths of depression metallurgists are in demand and can find the area for which they are best adapted and which appeals to them most, whether it be research, development, production or sales. If he shows executive capabilities the way is open for him to go to the very top, as many metallurgists have done, particularly in the producing industries.

Salaries

A recent survey of the American Society for Metals showed that the salary offered in the spring of 1959 for graduate metallurgists after a four year course leading to a bachelor's degree ranged from $450 to $500 per month—high for all engineers. Many companies offer a reduced work schedule at no reduction in salary to provide opportunity for advanced work leading to master's and doctor's degrees in metallurgical engineering and metallurgists with these degrees may receive as much as $300 a month more than those with a bachelor's degree.

Because of assignment of administrative duties, it is not easy to say what the income of a metallurgist is a few years out of college. From a recent survey of the American Society for Metals, "metallurgists" and "metallurgical engineers" with 20 years' experience have an average salary of $12,600. In common with all engineers and unlike the other learned professions, average salaries for metallurgists increase up until retirement. Many metallurgists continue in a consulting capacity long after "retirement" age.

Metallurgy in the Future

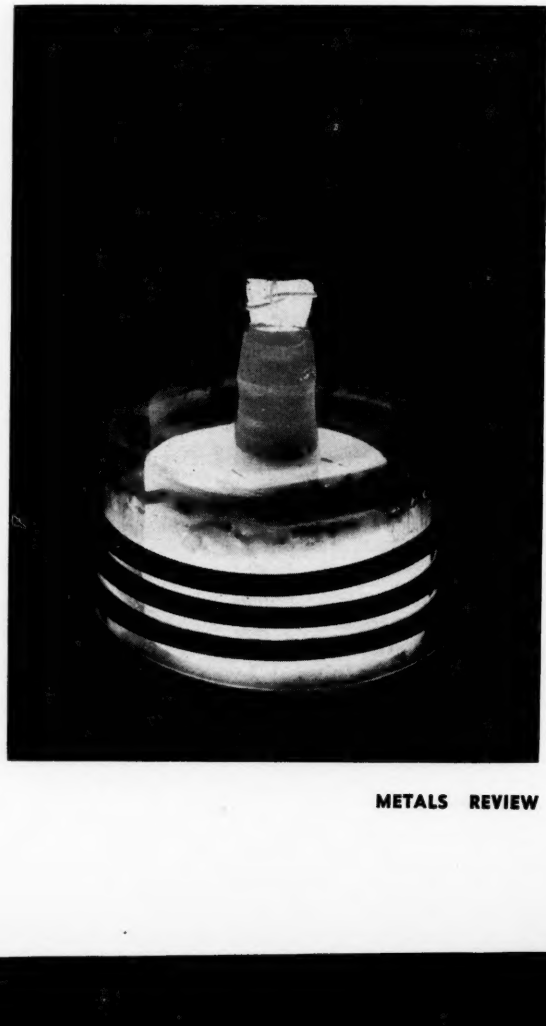
The future and progress of metallurgy is almost without limit. We are delving into areas beyond the wildest imagination. Submarines that can travel a dozen times around the world without pausing to refuel, earth satellites in ever-increasing number, only a step removed from interplanetary travel. The materials to go into these celestial travellers and new devices for world travel will tax our ingenuity and more. But these are the thrilling adventures for you!

Much closer home, the problems that confront us are without number. Mentioned earlier were the enormous costs of corrosion in chemical plant equipment. Think also of corrosion of automobile bodies and trim, of water piping, of farm equipment. Jet engines for airplanes, locomotives, trucks and pleasure cars must operate at much higher temperatures to be economically successful. Electronic ovens and a host of other conveniences in the household are with us now. Our thinking is already turned to new safety devices on the highway, such as radar controls whereby we can travel the superhighways and completely forget the wheel, arriving at our destination surely and safely.

Every service we can think of will call for new and better metal combinations. Our dreams cannot come true until these new alloys become available. Every man-made thing we see, every man-made thing we use depends upon metallurgy and metallurgists.

Can anyone believe this progress will stop? Can anyone believe we will never need metallurgists—more and more metallurgists?

A Glowing Crucible Lights Up a Special Oriented Copper Bi-Crystal Being Prepared at Battelle Memorial Institute. This and other similar crystals provide the basis for a study sponsored by Wright Air Development Center's Aeronautical Research Laboratory on Interdiffusion of Metals



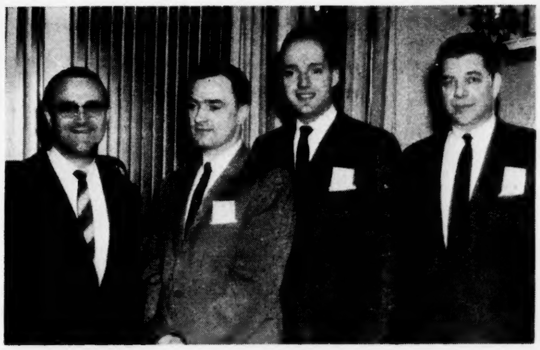
New Techniques in Powder Metal Processing

AT THE EASTERN NEW YORK CHAPTER'S panel discussion on "New Techniques in Powder Metal Processing", Harold Hirsch, General Electric Research Laboratory, acted as moderator, and Doug St. Pierre, General Electric Research Laboratory, Richard Smucker, E. W. Bliss Co., and Jack Yoblin, Manufacturing Services, General Electric Co., were panel members.

Jack Yoblin spoke about the use of hot pressing in consolidating powder parts. The metal powder is simultaneously heated and pressed with heat produced by passing an electrical current through the powder or by induction heating. The hot pressing can be carried out in a vacuum or special atmosphere. Much work is being done on the refractory and reactive metals. Hot extrusion and explosive compacting processes are essentially hot pressing.

In slip casting, described by Mr. St. Pierre, fine metal powders are deposited in a mold by means of a slip which is a stable mixture of the powder in a suitable vehicle. The apparent viscosity of the slip is dependent on both the surface reactivity of the particles and the coarseness of the particles. Molybdenum and tungsten are commonly slip cast. The rheology of the process is a definite problem, but this old technique newly applied to powder metallurgy will undoubtedly see much wider use in the future.

Richard Smucker described the continuous powder rolling of copper sheet. In this process, metal powder is passed between two rolls where the powder is compacted into a sheet prior to sintering. The maximum practical thickness of copper sheet produced is about 0.05 in. This new technique will find application in many other materials. *(Reported by Louis Ianniello for Eastern New York).*



A "Powder Metal Processing" Panel at Eastern New York Featured Harold Hirsch, General Electric Research Laboratories, Moderator, Doug St. Pierre, General Electric Research Laboratories, Jack Yoblin, General Electric Co., and Richard Smucker, E. W. Bliss Co.

Tells Explosive Forming Story at Hartford

ALLAN T. FULLER, JR., MANAGER, technical services, National Northern Division, American Potash & Chemical Corp., spoke on "Explosive Forming" at Hartford.

Following a description of the principles and techniques involved in explosive forming, Mr. Fuller presented a movie which showed examples of parts formed and actual operations of forming various parts.

The parameters of four variables must be determined when considering how to form parts with high energy explosives. These variables are the type of explosive, amount of explosive, position of the explosive with respect to the part and shape of the explosive. The explosive may be pressed or cast. The amount of explosive must be selected to avoid damage to the part and die. Positioning of the explosive is usually very critical for successful forming. The optimum shape of the charge must be determined to provide most efficient forming. When the values of these variables have been established, highly uniform results and close tolerances may be achieved.

Choice of die material is based on costs and the quantity of production. Fiberglas Kirksite and cast steel have been used successfully. Quite inexpensive dies or molds frequently may be used for a small number of parts.

The medium in which the explosive energy is transmitted to the part is generally water. The efficiency of the energy transmission increases as the density of the medium increases. Clay, talc, silicones and oil have also been tried as media.

Some work has been done on hot and cold forging using high-energy explosives. Considerable interest has been expressed in developments of this technique. The possible advantage of being able to form very large forgings without large presses is attractive.

Mr. Fuller concluded his talk with the comment that 5% of all forming operations could be advantageously performed by explosive forming. Guidance by people with experience in the field is required to evaluate technical and economic considerations. With proper safety standards and controls, this process can be quite acceptable to in-door application and small parts, and can become a semiproduction technique. (Reported by F. M. Lister for Hartford).

Honorary Metallurgical Fraternity Expanding

ALPHA SIGMA MU was founded in 1932 at Michigan College of Mining and Technology for the purpose of honoring metallurgy students of high scholastic standing in the graduate and undergraduate field. Honorary memberships in the fraternity are also awarded to alumni who have made outstanding contributions in the field of metallurgy.

Subsequent to the formation of the first chapter at Houghton, Mich., a second was formed at the University of Illinois and a third at Virginia Polytechnic Institute. Last year the Missouri School of Mines and Metallurgy became the fourth school to be awarded an Alpha Sigma Mu chapter. Since 1956 the American Society for Metals has been lending active aid to Alpha Sigma Mu for the express purpose of strengthening the fraternity and gaining wider acceptance, particularly at colleges and universities where no chapters currently exist. William A. Pennington, head of the department of metallurgy, University of Maryland, and member of the Board of Trustees of Alpha Sigma Mu, is working toward wider recognition of the fraternity.

Members at large have already been elected into the Alpha Sigma Mu from over 30 different colleges and universities throughout the United States, upon recommendation of the head of the departments of metallurgy. The most recent nominations were received from:

- University of Cincinnati
- Columbia University
- Cornell University
- Fenn College
- University of Kansas
- University of Kentucky
- Lafayette College
- University of Maryland
- Michigan State University
- New York University
- North Carolina State College
- Notre Dame University
- Ohio State University
- University of Pennsylvania
- Texas Western College
- University of Washington
- Wayne State University

To be eligible for membership, a student must be in the upper third of the engineering student body and upper fourth in the metallurgical department. In addition, students should possess exceptional qualities in integrity, initiative and leadership.

Several other schools are already petitioning for a charter into the Alpha Sigma Mu Fraternity and it is believed that the fraternity will soon become a widely recognized honorary body.

Members of Alpha Sigma Mu Fraternity at Missouri School of Mines and Metallurgy Include, Front, From Left: A. Legsdin and D. S. Eppelsheimer, Professors, C. L. Wilson, Dean, and H. R. Hanley, A. W. Schlechten, T. M. Morris and W. A. Frad, Staff; Second Row: R. V. Wolf, Staff, and R. W. Jones, J. V. Marler, R. C. Fabiniak, I. L. Spencer, H. B. Pressley and C. C. Myers; Third Row: R. H. Rath, T. J. Fabiniak, R. G. Schierding, R. B. Herchenroeder, D. J. Padberg and M. E. Horton; Fourth Row: L. A. Neumeier, W. F. Dennison, C. A. Washburn, T. R. Colandrea and R. A. Kibler

Quality Heat Treating Atmospheres

Shown at Canton-Massillon Are, From Left: C. D. Huff, Vice-Chairman; Jim Robinson, Canton-McKinley High School; C. W. Sanzenbacher, Surface Combustion Corp., the Speaker; and G. T. Piper, Technical Chairman

A TALK ENTITLED "GENERATING Atmospheres for Quality Heat Treating" was presented before the Canton-Massillon Chapter by Charles W. Sanzenbacher, process engineer in the research and development department of the Surface Combustion Corp.

In covering the most widely used furnace atmospheres, Mr. Sanzenbacher stated that an atmosphere of flue gas is still used for heat treating today in applications such as soaking pit heating as well as in many of the nonferrous processes.

However, according to Mr. Sanzenbacher, the most common gas used today for furnace atmosphere is fuel gas, which is produced by the combustion of hydrocarbon fuel gases with air in an exothermic generator. This gas is very economical and requires only simple equipment to produce.

Hydrogen, another widely used furnace atmosphere, is commonly produced by the electrolytic dissociation of water into oxygen and hydrogen. The hydrogen must then be purified and the moisture removed. The speaker pointed out that a popular application of this atmosphere is in the bright annealing process where all oxygen must be eliminated to prevent discoloration.

The endothermic generation of dissociated ammonia provides a high-purity, low-cost substitute for hydrogen. The only applications where it cannot be used in place of hydrogen is where a slight nitriding effect cannot be tolerated. Dissociated ammonia is preferred in many cases since it is lower in cost than pure hydrogen, more easily available and requires no purification or drying.

The meeting was closed with an interesting question and answer period. (Reported by Lanny L. Byrer for Canton-Massillon).

Groups Plan Varied Courses, Conferences and Symposiums

A widely divergent series of conferences, short courses and symposiums are planned for the late spring and summer season by schools, conference groups and societies. Among those announced as of special interest to metallurgists and metallurgical engineers are:

Course in Thermoelectric Materials and Devices, June 13 through 17, New York University.

Titanium Metallurgy Conference, Sept. 12 and 13, New York University.

Symposium on Engineering Aspects of Solidification of Metals, Aug. 22 to 26, Massachusetts Institute of Technology.

Gordon Research Conferences—Solid State Studies in Ceramics, Aug. 1 to 5; Physical Metallurgy—Relation of Structure and Properties, June 27 to July 1; Kimball Union Academy, Meriden, N. H.

Symposium on Refractory Metals and Alloys, AIME, May 25 and 26, Wayne State University, Detroit, Mich.

Ceramics Course for Investment Casting, Investment Casting Institute, June 14 to 17, Alfred University, Alfred, N. Y.

UCLA Short Courses — Plasma Physics: Theory and Applications, July 11 to 22; Structural Sandwich Design and Fabrication, July 11 to 16; Metal Forming, July 18 to 29, University of California, Los Angeles.

Columbium Metallurgy Symposium, AIME, June 9 and 10, Hotel Sagamore, Bolten Landing, Lake George, N. Y.

The Electron Microbeam Probe and Its Application, Aug. 15 to 26, Massachusetts Institute of Technology.

Pictured at a Michigan College of Mining and Technology Meeting Are, From Left: E. W. Olson, Chairman; R. R. Fritz, Who Gave a Talk Entitled "Why I Am a Metallurgist"; and G. J. Scott, Secretary.

Emphasizes Role of Metallurgists in Modern Society

R. R. FRITZ, SALES ENGINEER, Lindberg Engineering Co., and secretary of the Chicago Chapter, presented a talk entitled "Why I Am a Metallurgist", at a Michigan College of Mining and Technology meeting. Mr. Fritz is a 1946 metallurgical engineering graduate of Tech.

He emphasized the dual artistic and scientific nature of metallurgy, as defined by Webster, and discussed the intermediate position of the metallurgist in the spectrum of engineering. Taking the ore found by the geologist and removed by the miner, he treats it mechanically (mineral dressing) and chemically (extracting and refining), then alloys, shapes and heat treats to the specifications of the utilizing engineers—mechanical, electrical, civil, etc.

Mr. Fritz then described how he became a metallurgist, giving much of the credit to a family friend who was a metallurgist. After describing briefly his educational and working career, he raised and answered a question very important to the predominantly student membership of the Chapter; namely, "Who employs metallurgists and what do they do?"

He answered by stating that over 35,000 organizations hire metallurgists for jobs in eight basic fields. The first is in laboratories doing quality control work where metallurgists are responsible for day-to-day maintenance of production standards. Metallurgists also find places in proving, developing and designing metallurgical processes in the engineering aspect of metallurgy. Manufacturing provides jobs to over half the supply of metallurgists. These men act primarily as materials consultants to their organizations. Research metallurgists generate ideas for new products and processes. Metallurgists are employed by the government to conduct research and development for several bureaus. The education of the metallurgists of the future calls regretably few of the metallurgists of today into teaching.

The basic metals industries (i.e., aluminum, lead, zinc, copper, etc.) provide the metallurgist with perhaps the greatest opportunity to go to the top of his organization. The last major field in which metallurgists are employed is in management, where they fill positions from mill superintendents to general managers and vice-presidents.

Mr. Fritz showed a slide of the 1957 A.S.M. survey graph of salary versus years of experience with type of work (i.e., metallurgical or nonmetallurgical) as the parameter, which indicated that metallurgists and metallurgical engineers are more highly paid, on the average, than other engineers.

After describing his work as a salesman of industrial heating equipment, Mr. Fritz constructed an argument based on the A.S.M. survey graphs of salary versus experience, and salary versus amount of education, and the shortage of metallurgists (openings become available at the rate of about 1500 per year, and this year for example, about 750 metallurgists will be granted B.S. degrees), providing conclusively that metallurgists are better paid than other engineers with a comparable amount of education.

The challenge of solving problems in materials manufacturing and processing, improving the lot of mankind by creative metallurgy, the research and development aspects of providing space progress, jet engine and electronics technology, the socio-economic opportunity and security were all extensively explored from the working and student metallurgists' standpoint. (Reported by G. J. Scott).

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East

RESEARCH SUPERVISOR: Manufacturer of specialty steels desires a qualified engineer to supervise the activities in the electromechanical research field, including welding research, nondestructive testing research and quality control methods. Minimum of B.S. degree with three to five years experience, preferably in stainless steel fabrication or quality control. Position entails supervising engineers in the development of welding procedures, nondestructive testing methods and automation of quality control measurements. Salary commensurate with experience. Send resumé. Box 6-5.

METALLURGIST, PHYSICIST or PHYSICAL CHEMIST: Develop and apply new and improved materials for sensors for diverse line of instrumentation products (e.g., photoconductive and photovoltaic materials for photometric measurements; thermo-electric and resistance materials for high-temperature measurements). Position offers opportunity for professional growth by making significant contributions to products vital to the company's long-range objectives in the rapidly growing field of industrial automation. B.S. or M.S. degree in any one of the related disciplines and a record of accomplishment indicating creativity and a capacity to develop ideas into useful products. Write: H. E. Crabtree, Manager-Engineering Administration, General Electric Co., Instrument Dept., 40 Federal St., West Lynn, Mass.

PROJECT ENGINEER AND ASSISTANT: For protective coating development program on refractory metals, especially molybdenum. Familiarity with testing methods, statistical analysis and coating evaluation techniques desired. Salaries based on background and experience. Prospective employer a leader in its field. Metropolitan New York area. Box 6-15.

Midwest

SALES ENGINEER: Excellent opportunity with long-established manufacturer of industrial lubricants, coolants, cleaning compounds, protective coatings and chemical specialties for metalworking plants. Technical sales background essential and familiarity with local industry desirable. Territories open in Ohio and Michigan. Submit complete resumé. Box 6-10.

METALLURGICAL INSTRUCTOR: Male or female. Excellent opportunity to broaden metallurgical knowledge by working at A.S.M. headquarters in metallurgical home study and extension course division. Please state age, background and salary requirements. Write to: Metals Engineering Institute, Metals Park, Novelty, Ohio.

RESEARCH METALLURGIST: Opportunity with large Western Pennsylvania research and development organization for Ph.D. with experience. Physical metallurgy research on the effect of chemical composition, hardenability, heat treating variables and microstructure, including grain boundary constituents, on desired properties of alloy steels. Reply giving complete information and salary requirements. Box 6-20.

PHYSICAL METALLURGIST: Opportunity in large Western Pennsylvania research and development organization for recent B.S. or M.S. graduate having sound educational background in physical metallurgy. Applicants with knowledge of X-ray diffraction and metallography preferred. Experience desirable but not essential. Reply giving complete information and salary requirements. Box 6-25.

CERAMIC ENGINEERS: With one to five years experience in the application of refractories of all types, preferably in the iron and steel industry, to work with an expanding refractory application, control and development organization in a large and extremely diversified iron and steel producing facility. Openings available for graduate ceramic engineers, or other engineers with experience in this field who have a working knowledge of refractory applications and control in blast furnaces, various steel producing processes and rolling mills. If you desire a challenging opportunity for professional growth and advancement in this and other fields, send complete resumé. Box 6-30.

METALLURGICAL ENGINEER: B.S. degree, age to 40, for customer contact, sales development, complaints, etc., cold finished steel bars. Opportunity for growth, advancement, administration. Written replies will be held in strict confidence. Write: C. H. Scott, Manager of Sales, Bliss & Laughlin, Inc., 21000 Hoover Rd., Warren, Mich.

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West

DEVELOPMENT ENGINEER: Graduate with 5 to 15 years experience in metallurgy and design. Job consists of heading a development group dealing primarily with new fabrication methods and stainless steel sandwich structures. Salary commensurate with experience. Send resumé to: D. Z. Chapman, Chief Engineer, Aeronca Manufacturing Corp., Aerocal Div., 24751 S. Crenshaw Blvd., Torrance, Calif.

RESEARCH METALLURGIST: Preferably with Ph.D. or equivalent, for research and development in the field of physical metallurgy of aluminum alloys. Salary commensurate with experience, plus liberal employee benefits. Location in Pacific Northwest. Box 6-35.

PROCESS ENGINEER: Aggressive Southern California investment foundry, ferrous and nonferrous, offers opportunity to engineer, with successful investment casting background, who has tooling, metallurgical or process development experience. For interview, send resume to: Rex Precision Products, Inc., 11825 Major St., Culver City, Calif.

POSITIONS WANTED

METALLOGRAPHER: Ten years experience and education in metallographic laboratory work including work on exotic, refractory and high-temperature alloys. Set-up and headed two small laboratories. Interested in research and development control or trouble shooting. Small firm in New England preferred. Resumé on request. Box 6-40.

LABORATORY METALLURGIST: B.S. degree, age 28, married. Experience includes development and industrial analysis work on steels, stainless steels and high-temperature alloys, as related to brazing and heat treating. Available June 1. Resumé on request. Box 6-45.

METALLURGIST: B.A. degree, age 35, married. Eight years experience in basic and applied physical metallurgy in A.E.C. installation, chemical and aircraft industries. Experienced in material evaluations, metal joining and mechanical testing. Desires position with supervisory responsibility. Resumé on request. Box 6-50.

METALLURGICAL TECHNOLOGY STUDENT: A.A.S. degree. Desires challenging position in the metallurgical field. Age 24, married, veteran. Will relocate. Graduates August 1960. Resumé on request. Box 6-55.

METALLURGIST: Reactive metals experience for six years in the materials, quality control and process engineering areas of melting operations; six years as quality control and production supervisor of electrolytic refineries; working knowledge of steel consumable electrode melting, powder metallurgy, ultrasonics and missile materials engineering. Age 40. Efficient and reliable. Box 6-60.

METALLURGIST: B.S. degree with some advanced studies. Married, no children, age 26. Desires research and development or production. Over 4½ years experience in research and development including laboratory supervision. Experience includes induction melted, high fatigue strength steels, solid state conversion of titanium sponge and various testing programs. Resumé on request. Box 6-65.

METALLURGICAL ENGINEER: B.S. degree, registered professional engineer. Ten years experience in jet engine, nuclear, missile and automotive industries. Experience includes heat treating, brazing, welding, forging and specification writing for most engineering alloys. Will relocate for responsible position. Mountain States preferred. Will consider foreign assignment. Box 6-70.

METALLURGIST-SUPERVISOR: Age 36, B.S., M.S. degrees, additional graduate work and teaching. Ten years industrial research and development experience, largely at supervisory level. Broad background in theoretical metallurgy, processes, properties, testing, applications. Desires significant responsibility and opportunity developing and directing technical program at $13,500 level. Box 6-75.

MACHINE DESIGNER: Age 42, excellent background in development of oil well completion tools. Now chief engineer for small company. Desires departmental or project responsibility, preferably in Southwest. Salary $850. Box 6-80.

METALLURGIST: M.S.Met.Eng. Five years in research, alloy development and transformational studies; 15 years as chief metallurgist; 3 years teaching; 2 years in nuclear activity. Excellent theoretical and practical background in welding, metal fabrication, materials, metal finishing and inspection. Prolific technical writer. Will consider position in teaching, research or as laboratory director. Resumé on request. Box 6-85.

METALLURGICAL ENGINEER: B.S. degree, age 39, family. Army combat engineering, safety engineer, auditor (casualty insurance), five years teaching in engineering college (present job); foundry fundamentals; patterns, sand molding (green, shell, CO_2, etc.), permanent, die, investment, Shaw, etc. related design, inspection tours. Wishes to locate in Southwest or Western Florida. Box 6-90.

METALLURGICAL ENGINEER: B.S. degree, age 27, married. Background in titanium, refractory metals, refractory hard metals and ceramics. Very familiar with metallurgical testing and fabrication processes, including plasma spraying and powder metallurgy. Experience in specifications and service failures. Good report writer. Desires opportunity with progressive, stable company with good advancement potential. Box 6-95.

SALES METALLURGIST: M.S., B.S. degrees in metallurgical engineering. Age 27, married. Desires metallurgical engineering sales position, preferably New England or Northeast. Three years experience in the fields of high-temperature metallurgy, welding, brazing and fabrication of materials. Available August. Box 6-100.

INDUSTRIAL METALLURGIST: Desires supervisory position in heat treat or in sales pertaining to heat treat equipment. Twenty years in steel industry under government supervision. Complete resumé on request. Box 6-105.

METALLURGICAL ENGINEER: B.S. degree, with 18 years experience in production and research and development. Directed the research and development programs for a large aircraft company for eight years. Excellent experience in the heat treating of metals, welding, brazing, materials evaluation, service failure analysis, machineability and trouble shooting on all types of production problems. Capable supervisor and manager. Desires responsible position. Box 6-110.

MECHANICAL METALLURGIST: Ph.D. in 1949. Age 39. Broad research experience in flow and fracture of metals and alloys, particularly at high temperatures. Supervisory position for five years. Interested in administrative or executive position in research and development. Box 6-115.

METALLURGIST: With management as a career objective, desires challenging opportunity. B.S., M.S. degrees in metallurgy, M.S. degree in business administration. Four years diversified metallurgical and foundry experience in aircraft and missile field. Age 25, married, veteran, will relocate. Resumé on request. Box 6-120.

METALLURGIST: With 18 years broad experience, both line and administrative,

servicing engineering and manufacturing in electrical appliance, can, instrument and razor blade industries. Conducted research and development for product application including wear resistance, heat treatment, furnace atmosphere generators, corrosion, welding, brazing and soldering. Developed material purchase and process specifications. Prefers nondefense industry. Box 6-125.

TECHNICIAN: Experience as machinist in aircraft company (England), foreman in metallographic machine shop, which included design and fabrication of wear testing equipment (England); designer-draftsman; design of scientific instruments for the chemistry division of Canadian research organization, including a patent-pending design for mechanized titrimeter. Also experienced as technical illustrator. Would like to locate in northern state in U.S., prefers Boston. Box 6-130.

PHYSICAL TESTER: Young German girl with experience and company training in the physical testing of hard metals and high-speed steels, would like to locate in the United States. Experience includes laboratory work on inspection instruments, measurements, graphs, and preparation of specimens for metallographic testing. Thoroughly familiar with the physical testing of cemented carbides. Box 6-135.

EXECUTIVE: Management engineer, with 25 years diversified experience in metal and appliance industries. Seasoned in all phases of manufacturing, engineering and sales. Detailed in welding engineering, metallurgy, production engineering, liaison and contracts, product design, factory cost accounting and labor relations. Box 6-145.

METALLOGRAPHER: B.S. degree, age 29, family. Eight years experience in aircraft and jet engine materials testing. Capable of supervision and decisions. Will relocate to any area. Resume sent on request. Box 6-150.

METALLURGICAL ENGINEER: B.S. degree, age 35, veteran, married. Eight and one half years diversified experience in the aircraft, missile and nuclear fields. Background in process control, material application and development work. Desires responsible position with a challenging future in the Midwest. Box 6-155.

METALLURGICAL ENGINEER: B.S. Met.-Eng. Four years experience in materials selection, evaluation, heat treatment, processing of high-strength steels, stainless alloys for aircraft, missile and gas turbine applications. Five years casting gray iron, nodular iron and stainless alloys in sand and shell molding. Resume on request. Will relocate. Box 6-160.

PHYSICAL METALLURGIST: Age 44, with 17 years experience in fields of metallography, physical testing, plant failure investigations, heat treating, electroplating, surface treatments and radiography. Twelve years in nuclear diffusion plants. Two years in research and development of alloys for such plants. Southern location preferred. Resume on request. Box 6-165.

METALLURGIST: B.S. in Met. Eng., age 35, veteran, married. Three years experience in research and development of nuclear fuel alloys; three years as production metallurgist in fabrication, welding, heat treatment of nuclear components. Desires position in research, development or fabrication. Prefers East Coast. Box 6-170.

SUPERVISING RESEARCH AND DEVELOPMENT METALLURGIST: Heavy experience in research and development supervision plus prior top-notch engineering work. Knows research and development personnel; program planning, budgeting and execution. Broad experience with high-temperature alloys, cast iron, steels, aluminum, reactive metals and ceramics. Mid-30's, M.S. degree, publications. Medium or small company preferred. Box 6-175.

PLATING ENGINEER: Chemistry and metallurgy background. Twenty years diversified experience in production and technical control of large and small electroplating and heat treating facilities. Heavy experience in gold and silver specialized plating and barrel chromizing. Considerable sales liaison, research and development ability. Desires position in New York City vicinity. Box 6-180.

METALLURGICAL-NUCLEAR ENGINEER: B.S. Met. Eng., ORSORT, age 32, single. Experience includes: fuel material development by powder metallurgy and casting; technical liaison; designing and conduction in-pile experiments; evaluation of in-pile behavior of fuel and control materials. Desires position involving technical evaluation, technical liaison and planning. Salary $11,000. Box 6-185.

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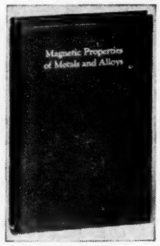

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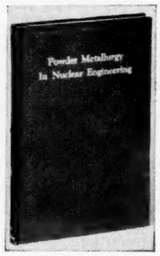

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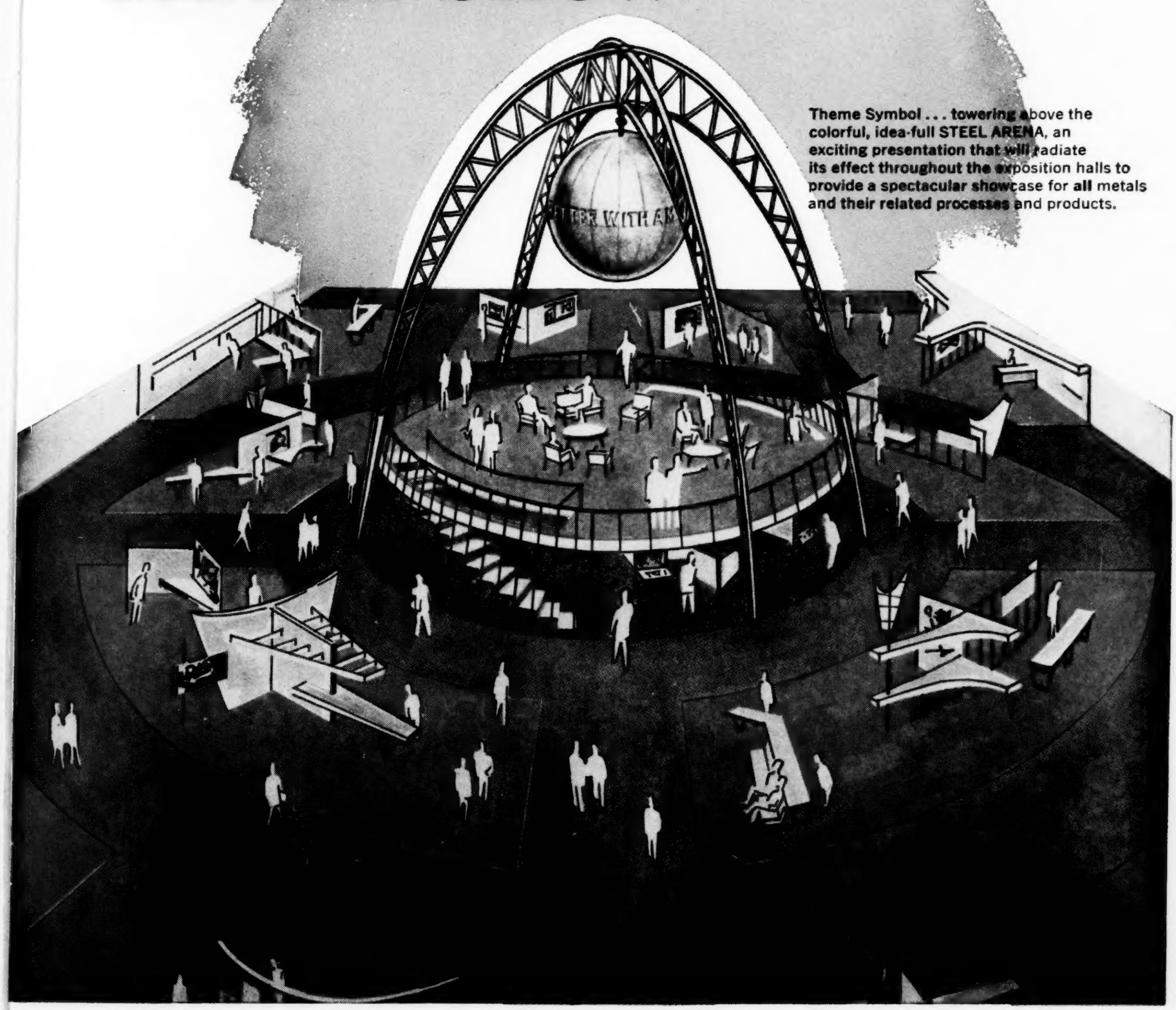

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